Technical Assistance Services *for* Communities
DePue/New Jersey Zinc/Mobil Chemical Corp. Superfund Site
Ecological Risk Assessment Review Report

Contract No.: EP-W-13-015
Task Order No.: 18
Technical Directive No.: R5 2.2.2 DePue

Introduction

In December 2017, the DePue Community Advisory Group (CAG) requested that the U.S. Environmental Protection Agency's (USEPA's) Technical Assistance Services for Communities (TASC) program conduct a review of a presentation and prior background information on the Baseline Ecological Risk Assessment (BERA) for the operable unit 5 (OU5) at DePue/New Jersey Zinc/Mobil Chemical Corp. Superfund site (the Site). TASC participated in a call with Illinois EPA (IEPA) and the CAG on February 15, 2018, regarding updated BERA information. The review below focuses primarily on the topics presented by IEPA regarding the risk assessment for aquatic insects, worms and clams living in the sediment at the bottom of Lake DePue and the effects of contamination on their survival. Independent technical and environmental consultants implement the TASC program. The report's contents do not necessarily reflect the policies, actions or positions of EPA. TASC prepared this review report for the DePue Superfund CAG.

Site Background

The Site is located in the northern part of the Village of DePue. It includes about half of the village's land area. The Site is a state enforcement-lead site – IEPA is the lead agency. To manage site investigations and cleanup, IEPA divided the Site into five OUs.

OU5 includes Lake DePue and lowland areas surrounding the lake up to an elevation of 450 feet above mean sea level. Parts of the lowland areas occasionally flood. The lowland areas include: 1) the South Ditch (OU1) and the Lowland Portion of the Southeast Area; 2) the spring area west of the former Settling Ponds; 3) the Division Street outfall; 4) the DePue wastewater treatment plant (WWTP); 5) the Southwest Drain and Unnamed Tributary; and 6) the wildlife management area, including the Dredged Sediment Disposal Area (DSDA), south of Lake DePue.

OU5 Ecological Risk Assessment-Related Concerns Identified by TASC

TASC has provided technical comments on previous site documents, including the Proposed Plan for OU4, the Screening Level Human Health Risk Evaluation (SLHHRE) for OU3, the 2015 OU4 Scoping Document for Presumptive Remedy and the May 2014 Pilot Study Sampling Report. Based on those prior reviews, discussions with the CAG and IEPA, and a review of the OU5 BERA, TASC developed this review report to address the following concerns and questions shared by the CAG and/or identified by TASC:

- *What is the role of the Superfund process and risk assessment in site reuse?*
- *What are Probable Effect Concentrations (PECs)?*
    - *How does combining PEC values for multiple contaminants into a single mean PEC-Q value affect the potential risk from a single contaminant?*
    - *How was the threshold mean PEC-Q for toxicity developed in the BERA?*
    - *How are species sensitivity and long-term exposure to contamination assessed in the BERA?*
    - *How is sediment type accounted for in the PEC values?*
- *How well does bioavailability data predict toxicity?*
- *How does the sediment sampling depth take future site use into account?*
- *How does the western arm of Lake DePue contribute to aquatic toxicity?*
- *What are the sources of ammonia in Lake DePue and what role does it play in toxicity at the lake?*
- *How was the Quality Control Plan used in the BERA?*

Comments

1. What is the role of the Superfund process and risk assessment in site reuse?

The CAG asked how risk assessment fits into the cleanup process and how future expected use of the Site will be impacted by the risk assessment and cleanup goals. IEPA used the BERA to understand the risks posed by contaminants in the water, sediment and soil to animals in the area in and surrounding the lake. If the risks are unacceptable, the IEPA uses the risk assessment to identify levels of contamination considered safe. These levels are known as cleanup goals. Site owners and stakeholders cannot reuse a site until IEPA knows whether the contamination poses unacceptable health risks to people and wildlife. IEPA and site owners and stakeholders can consider site reuse as risks are assessed and cleanup goals are determined, during development of the cleanup plan. For example, if Lake DePue sediments need to be cleaned up and reuse plans call for a boating hub in the area, it will be important to make sure the area is deep enough to accommodate boats and that sediment contamination is protected from disturbance.

TASC Comments: The CAG could ask if IEPA has considered future use in the sampling design and risk assessment process, and when a discussion about future use may be most relevant. The CAG could consider tools for developing reuse plans that coincide with cleanup strategies.

USEPA provides communities with support to develop reuse plans for sites. To learn more, visit: https://www.epa.gov/superfund-redevelopment-initiative.

2. *What are PECs?*

A PEC is a screening level used to determine if sediments are potentially harmful to aquatic life. PECs are chemical-specific values based on the results of toxicity tests conducted by scientists at sites across the United States. The scientists reviewed the results of the toxicity tests and developed PECs to represent the average concentration of each contaminant likely to result in harmful effects on aquatic life.

In the OU5 BERA, PEC values were compared to contaminant concentrations detected in site sediments. The ratio of a site concentration to a PEC is called a PEC quotient, or PEC-Q. The BERA calculated separate PEC-Q values for each chemical at each sample location. The chemical-specific PEC-Qs were then added together to get a total PEC-Q. The total PEC-Q was then averaged based on the number of chemicals detected at that sample location to estimate the average (also referred to as the "mean") PEC-Q for all chemicals in a sample. While a mean PEC-Q greater than 1 does not automatically indicate that the sediment is toxic to aquatic life, it does provide a preliminary guideline for areas that might be harmful to aquatic life.

To determine if site sediment is toxic to aquatic life, the BERA used the mean PEC-Q results along with other site-specific information to determine the likelihood that the sediments are toxic to aquatic life. The site-specific information that the BERA considered included measures of bioavailability (discussed further below), toxicity tests using sediment from Lake DePue, and a field survey to identify the types of aquatic organisms living in the sediment. The BERA uses this information to determine the need for additional studies or if enough information is available to conclude that the contaminated sediment needs to be cleaned up.

The PEC-Q values varied across Lake DePue, from 0.18 to 61 (next to the Division Street Outfall). PEC-Q values from the seeps along the lake ranged from 0.11 to 62. The highest PEC-Q values were for cadmium, copper, lead and zinc.

How does combining PEC values for multiple contaminants into a single mean PEC-Q value affect the potential risk from a single contaminant?

To design a sediment cleanup plan, site areas and the size of the areas needing cleanup must first be identified. This is done by ranking each sample location based on the potential severity of risk that each sample may pose to aquatic life. The mean PEC-Q was developed, per BERA guidance from USEPA, to represent a single value per sample location that takes into account the contribution of risk from all the chemicals detected at that location.[1] The use of mean-PEC-Q values allows each sample location to be ranked to identify parts of the lake that may pose higher potential health risks to aquatic life relative to other sample locations. USGS's guidance states that combining the information from all contaminants can help understand the overall effect of

[1] USEPA. 1998. Guidelines for Ecological Risk Assessment. https://www.epa.gov/risk/guidelines-ecological-risk-assessment.

contamination.[2] Several states, including Georgia, Florida, Indiana, Massachusetts, Michigan, Pennsylvania and Wisconsin, use the same approach used in the BERA, where the effects of contaminants on aquatic life are identified based on a range of studies and findings from sites across the United States. Mean PEC-Qs can be useful for ranking portions of the lake to help prioritize the cleanup process.

However, when only a single contaminant has a high PEC-Q value and all other contaminant values are low, the mean PEC-Q could be low and not be seen as a risk to aquatic life. Sample K1.5 in the OU5 BERA is an example of this outcome. For this sample, the mean PEC-Q is 0.64 but the PEC-Q value for zinc alone is 2.64. The same is true for several samples from across the lake. The result is that fewer samples appear to exceed the risk threshold, even though the PEC-Q for cadmium and zinc alone exceed the threshold. This approach also assumes that metals do not interact with each other to amplify the toxicity to aquatic life.

***TASC Comments*:** TASC recommends that the CAG ask IEPA for a comparison map showing only zinc and cadmium PEC-Q values, with the understanding that PEC-Q values are part of the overall risk evaluation. TASC also recommends that the CAG ask the IEPA to provide information about whether metals interact with each other to affect toxicity to aquatic life. Some studies have found that metals interact to affect toxicity more than would be expected by summing the risks from each individual contaminant.

How was the threshold mean PEC-Q for toxicity developed in the BERA?

IEPA and USEPA have slightly different guidelines when creating low-, medium- and high-risk rankings based on mean PEC-Q (Table 1). The threshold mean PEC-Q can vary from one region of the country to another, depending on regional differences in the type of sediment and the organisms living in the sediment. IEPA has established threshold mean PEC-Qs that are specific to Lake DePue. These PEC-Qs serve as the standard to compare with the site-specific mean PEC-Q for each sample location to classify each sample as low, medium or high risk. According to threshold levels developed by IEPA, if a site sample has a mean PEC-Q greater than 7, it may be a high-risk sample. IEPA also looks at site-specific factors that may lower or raise the risk based on other information collected as part of the BERA process. These factors include bioavailability (discussed later), toxicity tests using sediment from Lake DePue, and a field survey to identify the types of aquatic organisms living in the sediment.

TASC Comments: TASC recommends that the CAG ask IEPA for clarification regarding how IEPA developed the thresholds for mean PEC-Qs to define low, medium and high-risk samples. TASC also recommends that the CAG ask for clarification regarding how the threshold of a

[2] U.S. Geological Survey. 2000. Prediction of Sediment Toxicity Using Consensus-based Freshwater Sediment Quality Guidelines. Prepared for USEPA. https://www.cerc.usgs.gov/pubs/center/pdfdocs/91126.pdf.

mean PEC-Q < 1.7 is considered “low risk” when this level can be equivalent of up to an incidence of effects as high as 50 percent of the exposed aquatic life.

Table 1. Comparison of IEPA and USEPA mean PEC-Q thresholds for toxicity. Incidence of effects in parentheses.

Incidence of Effects	IEPA Mean PEC-Q	USEPA Mean PEC-Q	Interpretation
20% - 50%	< 1.72	< 0.2	Low Risk: adverse effects are unlikely
50% - 95%	1.72 to 7	0.5 to 5.0	Medium Risk: adverse effects are possible
> 95%	> 7	> 5	High Risk: adverse effects Are probable

How are species sensitivity and long-term exposure to contamination assessed in the BERA?

As stated above, IEPA proposes that mean PEC-Q values below 1.72 are low risk and mean PEC-Q values greater than 7 are high risk. Mean PEC-Q values in between are medium risk. This approach limits high-risk areas to the northeast part of Lake DePue. Several published studies use lower threshold values for mean PEC-Q to define toxicity, typically ranging from 0.4 to 1.0. IEPA used a weight of evidence approach to understand risk, which includes indicators of biological health and toxicity tests. Species sensitivity is assessed with indices that examine the overall health of the aquatic life based on reference lakes and waterways. This assessment is also a potential indicator of long-term exposure. The community of organisms living at a location reflects the suitability of the habitat and the toxicity.

Guidance from USEPA and other agencies provides insight into understanding the sensitivity of aquatic life to long-term exposure to sediment contamination. Evaluation of a large freshwater database by USEPA found that mean PEC-Qs greater than 0.7 are likely to be toxic to sediment-dwelling organisms. When the study exposed animals to contaminated sediment for 14 days, 50 percent of the animals died at mean PEC-Qs greater than 0.7. When exposed for 28 days, 100 percent of the animals died at a mean PEC-Q of 4.0. The study concluded that, because sediment-dwelling animals are likely to be exposed to contaminated sediments for extended periods of time (i.e., > 30 days), sediments with mean PEC-Qs greater than 0.7 are sufficiently contaminated to harm sediment-dwelling animals.[3] The Minnesota Pollution Control Agency developed guidance for using PEC-Q values in remediation. The guidance states that mean PEC-Qs provide a means of establishing cleanup goals that fulfill the narrative use protection objections for a site. For example, targets could be set at mean PEC-Qs ≤0.1 if the site

[3] U.S. Geological Survey. 2000. Prediction of Sediment Toxicity Using Consensus-based Freshwater Sediment Quality Guidelines. Prepared for USEPA. https://www.cerc.usgs.gov/pubs/center/pdfdocs/91126.pdf.

management goal is to provide a high level of protection for sediment-dwelling organisms.[4] Alternatively, the goals could be set at a mean PEC-Q of 0.6 if the immediate goal for a site is to reduce the potential for acute toxicity and permit natural recovery processes to further reduce contaminant concentrations.

***TASC Comments*:** TASC suggests that the CAG ask IEPA about the sensitivity of organisms such as the fingernail clam and how their sensitivity to contaminants is incorporated into the risk assessment threshold levels and to long-term exposure to sediment contamination. PEC-Qs less than 0.4 can be toxic to mussels, and fingernail clams are a key benthic animal missing or in low numbers at Lake DePue. The mean PEC-Q for Goose Lake, the reference lake, is 0.4, which is similar to sediment contaminant levels in Lake DePue near its intersection with the Illinois River. The CAG could ask IEPA for a description of how reference mean PEC-Q values were used in the risk evaluation.

How is sediment type accounted for in the PEC values?

The type of sediment in Lake DePue can affect the potential toxicity of a contaminant to aquatic life. Site-specific sediment grain size and the amount of organic matter (e.g., decomposed leaves) was measured from samples at Lake DePue and Goose Lake and are not accounted for in the PEC screening values. The grain-size information is used to help understand if sediments contain the proper mix of sands, silt and clay that would allow certain aquatic animals to live in the sediment. The grain-size information helps determine why certain aquatic organisms may live in particular parts of a lake. Grain size also can help determine why some contaminants are higher in particular areas. For example, the BERA notes that some parts of Lake DePue are silty, while other parts have sediment that is sandy.

***TASC Comments*:** Using sediment types as a factor in risk assessment is useful because the amount of clay and organic matter in the sediment is one of the main factors affecting where chemicals may preferentially occur and how toxic they are to aquatic life.[5] For instance, one study found that samples with more silt had a lower percent of zinc, copper, cadmium, nickel and chromium in them, while samples with more sand and organic matter had higher levels of these metals. The Minnesota Pollution Control Agency guidance on sediment toxicity notes that uncertainty will be higher when using sediment samples to develop mean PEC-Qs at depositional sites such as Lake DePue. Sample data can be normalized based on grain size or amount of organic matter. TASC recommends that the CAG ask IEPA how sediment type and size were assessed and how this was used to evaluate sediment toxicity and habitat quality.

3. How well does bioavailability data predict toxicity?

The OU5 BERA evaluated the bioavailability of metals in the sediment samples by analyzing them using a laboratory procedure called simultaneously extracted metals (SEM)- acid-volatile

---

[4] Crane, J.L., D.D. MacDonald, C.G. Ingersoll, D.E. Smorong, R.A. Lindskoog, C.G. Severn, T.A. Berger and L.J. Field. 2002a. Evaluation of Numerical Sediment Quality Targets for the St. Louis River Area of Concern. Arch. Environ. Contam. Toxicol. 43:1-10.
[5] Farkas A., C. Erratico and L. Vigano. Assessment of the Environmental Significance of Heavy Metal Pollution in Surficial Sediments of the River Po. Chemosphere. 2007. 68:761–768.

sulfide (AVS). SEM-AVS results, along with measurement of the organic carbon content of the sediments, can help explain how tightly bound the metals are to sediment particles. While the BERA used an analytical procedure to see if the metals are bound tightly to the sediment (making the metals less likely to become available to aquatic life), this test may not always be a good predictor of toxicity.

There are several potential challenges associated with using SEM-AVS at the Site:

- There are many variabilities observed in results obtained in the field.[6]
- Bioavailability in 40 percent of the samples was uncertain. Additional information is needed to understand the uncertainty and the factors affecting bioavailability.
- Bioavailability data only determine if contaminants are toxic during short-term exposure. Since animals will be exposed to sediment contamination over long periods, bioavailability values may underestimate actual impacts.

TASC Comments: TASC recommends that the CAG ask IEPA about the reliability of the AVS-SEM analysis for determining site-specific bioavailability of metals, given that the results can be so variable. TASC also recommends that the CAG ask IEPA to explain the uncertainties in the use of AVS-SEM in predicting short-term and long-term toxicity to aquatic life in sediment. Lastly, TASC recommends that the CAG ask IEPA about potential differences in bioavailability for aquatic species that consume sediment, are predators or consume food from the water column, as bioavailability can change based on feeding styles.

4. How does the sediment sampling depth take future site use into account?

The BERA uses three sediment depths to develop the PEC-Q values; 6 inches, 6 inches to 1 foot, and 1 foot to 2 feet. In many cases (e.g., sample F7), the PEC-Q value increases with depth. However, IEPA used the data from the 6-inch depth to develop maps of mean PEC-Q values for its BERA presentation. Since PEC-Q values increased with sediment depth in parts of Lake DePue, such as in the western part of the lake, sediment disturbance could become an important consideration; such activity could bring more contaminated sediments to the surface.

TASC Comments: TASC recommends that the CAG ask IEPA if IEPA considered using mean PEC-Q values from greater depths to assess risk. TASC also recommends that the CAG ask IEPA how plans for dredging the lake were accounted for in the determination of toxicity for various parts of the lake. The depths evaluated in the BERA may not represent concentrations in the future if recontamination from deeper sediments occurred due to boat use on the lake or dredging the lake.

5. How does the western arm of Lake DePue contribute to aquatic toxicity?

The maps of mean PEC-Q levels in the lake in IEPA's BERA presentation indicate that contamination in the western arm of the lake poses a moderate risk to aquatic life. The original map (top map below) uses a mean PEC-Q value of 1.2 to indicate moderate risk, while the reviewed threshold of 1.7 is shown in the bottom map. Additionally, few, if any fingernail clams

[6] USEPA. 2007. Framework for Metals Risk Assessment. https://www.epa.gov/risk/framework-metals-risk-assessment.

were found in this portion of the lake, even though the highest concentration of this species was found at the inlet from the river, immediately adjacent to the western arm. The revised map also shows a small area of the western arm near the shore with moderate risk. The area is not discussed in the BERA or in IEPA's presentation.

TASC Comments: TASC recommends that the CAG ask IEPA about potential source contamination along the shoreline in the western arm of the lake. According to a discussion with the CAG, the land area between the western and eastern portions of the lake was historically connected by water before it filled in with sediment.

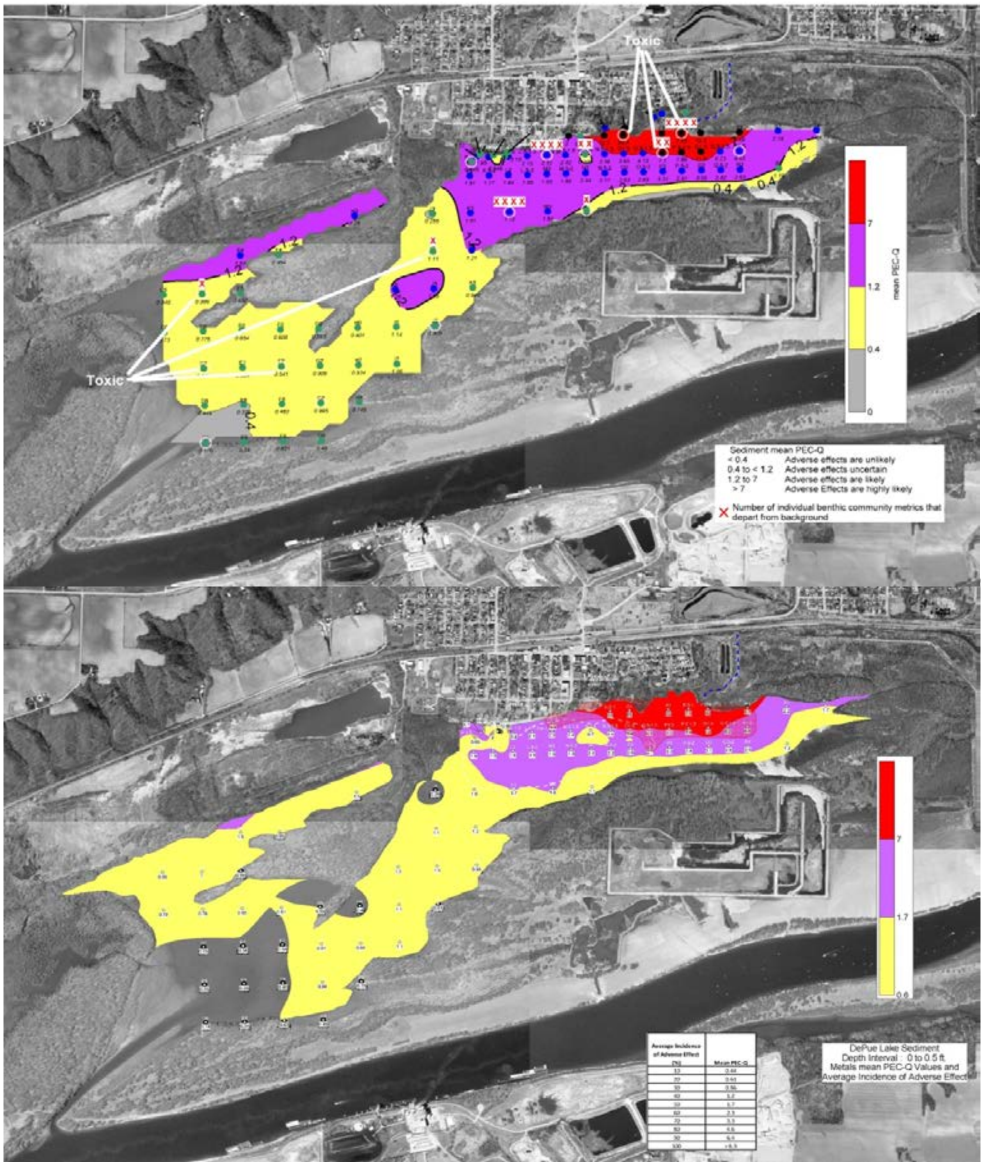

Figure 1. Map of mean PEC-Q values from IEPA presentation, during initial risk assessment (top) and revised risk assessment (bottom)

6. *What are the sources of ammonia in Lake DePue and what role does it play in toxicity at the lake?*

Ammonia is one of several forms of nitrogen that exist in aquatic environments. Ammonia is produced for use in commercial fertilizers and other industrial applications. Natural sources of ammonia include the decomposition or breakdown of organic waste matter, gas exchange with the atmosphere, forest fires, animal and human waste, and nitrogen fixation processes. Ammonia can enter the aquatic environment via direct means such as municipal effluent discharges and the excretion of nitrogenous wastes from animals, and indirect means such as nitrogen fixation, air deposition and runoff from agricultural lands.[7] When ammonia is present in water at high-enough levels, it is difficult for aquatic organisms to sufficiently excrete the chemical, leading to toxic buildup in internal tissues and blood, and potentially death. Ammonia can be directly toxic to aquatic life, with greater impacts at higher pH, low flow and warm water conditions.

In general, ammonia is converted relatively quickly to other forms of nitrogen in oxygenated waters. Thus, high ammonia concentrations likely indicate an active source. The BERA assumed ammonia concentrations originated from wastewater treatment plant discharge into Lake DePue. The BERA did not consider the former phosphate manufacturing facility at the Site as a potential source.

TASC Comments: The CAG could ask IEPA about the potential contribution of the former phosphate manufacturing facility to ammonia concentrations in the lake as another potential source and how inclusion of the manufacturing facility as a source could affect the BERA.

7. *How was the Quality Control Plan used in the BERA?*

The validity of the data collected at a site is assessed and managed using a Quality Assurance Project Plan (QAPP). The QAPP describes the way that data are collected, analyzed and used, during the remedial investigation, cleanup and monitoring in the case of the Superfund process. The QAPP includes protocols used in the field and the laboratory and states what happens if the sampling or lab analysis does not go as planned. The OU5 BERA does not mention the QAPP but notes that two of the lab samples tested for toxicity on lab organisms were discarded because predators contaminated the samples. Additionally, the toxicity tests were conducted on different days and control values were different on each day.

TASC Comment: The QAPP for the Site likely provides information on the approved approach for addressing changes in lab protocols, including whether samples should be re-analyzed. The BERA and IEPA's presentation did not discuss how the QAPP was used to make decisions about the laboratory analyses. The CAG would benefit from access to and interpretation of the QAPP, and its contingency plans in particular. Understanding quality control for lab and field work is important for all site studies, including the BERA. TASC recommends that the CAG ask for access to the Site's QAPP and a presentation on how QAPPs are used in the field as well as how QAPP deviations in the field are addressed to make sure data gaps do not occur.

[7] USEPA aquatic life criteria for ammonia. https://www.epa.gov/wqc/aquatic-life-criteria-ammonia.

Technical Assistance Services for Communities Contact Information

Technical Assistance Specialist/Project Manager
Tiffany Reed
847-786-8767
treed@skeo.com

Task Order Manager
Emily Chi
541-238-7516
echi@skeo.com

Senior Program Manager
Eric Marsh
817-752-3485
emarsh@skeo.com

Skeo Vice President, Director of Finance and Contracts
Briana Branham
434-226-4284
bbranham@skeo.com

TASC Quality Control Monitor
Bruce Engelbert
703-953-6675
bengelbert@skeo.com